



**JAN 18 2005**

L-2005-011

U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington DC 20555

RE: Florida Power and Light Company  
St. Lucie Units 1 and 2  
Docket Nos. 50-335 and 50-389

FPL Energy Seabrook, LLC  
Seabrook Station  
Docket No. 50-443

**NRC Bulletin 2004-01**  
**Request for Additional Information**  
**Inspection of Alloy 82/182/600 Materials Used In The Fabrication of**  
**Pressurizer Penetrations And Steam Space Piping Connections At**  
**Pressurized-Water Reactors**

On November 18, 2004 and November 23, 2004, the NRC issued requests for additional information to Bulletin (NRCB) 2004-01, "Inspection of Alloy 82/182/600 Materials Used in Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors," to FPL Energy Seabrook, LLC (FPL Energy Seabrook) the licensee for Seabrook Station and to Florida Power & Light Company (FPL), the licensee for the St. Lucie Nuclear Plant, Units 1 and 2, respectively.

Attachment 1 provides the requested information for FPL Energy Seabrook and Attachment 2 provides the requested information for FPL St. Lucie Unit 1 and Unit 2.

Please contact Rajiv S. Kundalkar at (561) 694-4848 if you have any additional questions regarding these responses.

Sincerely yours,

*for* 

J. A. Stall  
Senior Vice President, Nuclear and  
Chief Nuclear Officer

Attachments (2)

A110

Attachment 1

**NRC BULLETIN 2004-01: "INSPECTION OF ALLOY 82/182/600 MATERIALS USED IN  
THE FABRICATION OF PRESSURIZER PENETRATIONS AND STEAM SPACE PIPING  
CONNECTIONS AT PRESSURIZED WATER REACTORS,"  
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION  
FOR SEABROOK STATION**

FPL Energy Seabrook (Seabrook Station) responded to the Nuclear Regulatory Commission (NRC) Bulletin 2004-01 by letter dated July 27, 2004. <sup>[1]</sup> By letter dated November 18, 2004, the Nuclear Regulatory Commission (NRC) sent a request for additional information (RAI) regarding the FPL response to NRC Bulletin 2004-01 <sup>[2]</sup> for Seabrook Station. Below are the responses to those RAI questions.

**NRC RAI 1:** *In item (1)(c) of the licensee's response, it appears that the licensee is stating that they may not be examining the Alloy 182 spray, safety and surge nozzle butt welds after the next refueling outage. Please clarify this statement in your Bulletin response since on page 5 of the Bulletin it states, "The NRC staff has reviewed the recommendations made by the WOG in its January 30, 2004, letter and finds that, with minor modifications, it would constitute an effective degradation management program for all Alloy 82/182/600 covered under the scope of bulletin 2004-01 based on our current state of knowledge." These examinations should be performed at each refueling outage.*

**Seabrook Station Response to RAI 1:** FPL Energy Seabrook will perform a 100% bare metal visual examination (VT-2) of the alloy 82/182/600 pressurizer butt welds as identified in the original Bulletin 2004-01 response at the next refueling outage. That refueling outage is currently scheduled to start April 1, 2005. FPL Energy Seabrook had identified that for subsequent bare metal VT-2 examinations of the alloy 182 spray, safety, relief and surge nozzle butt welds, that Seabrook Station will follow a frequency to be identified by the ASME Code, EPRI MRP, or regulatory action. EPRI MRP is currently drafting further inspection guidance for all alloy 82/182 butt welds, which is due out in 2005. These inspection guidelines are expected to include an inspection frequency based on the temperature, size and level of mitigation that may have been previously applied. In the interim, FPL Energy Seabrook is modifying its response to indicate that Seabrook Station will continue to perform bare metal visual inspections of the alloy 182 spray, safety and surge nozzle butt welds at each refueling outage (RFO), until further butt weld inspection guidance is issued by EPRI MRP, the ASME Code, or regulatory action. At that time, FPL Energy Seabrook will follow the applicable published guidance.

**NRC RAI 2:** *Items 1(b) and 1(c) in Bulletin 2004-01 request that the licensee provide the basis for concluding that their plant will satisfy applicable regulatory requirements related to the structural and leakage integrity of pressurizer penetrations and steam space piping connections. The licensee's response to this item does not provide a specific explanation of these items. Please supplement your response to provide this basis. The section titled, "Applicable Regulatory Requirements" starting on page 5 in Bulletin 2004-01 lists some of the regulatory requirements that should be addressed in your response.*

**Seabrook Station Response to RAI 2:** The applicable general design criteria (GDC) identified in Bulletin 2004-01 includes GDC 14, GDC 31, and GDC 32. The three referenced general design criteria state the following:

- **Criterion 14 – Reactor Coolant Pressure Boundary:** "The reactor coolant pressure boundary shall be designed, fabricated, erected and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture."
- **Criterion 31 – Fracture Prevention of Reactor Coolant Pressure Boundary:** "The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a non-brittle manner, and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient thermal stresses, and (4) flaw sizes."
- **Criterion 32 – Inspection of Reactor Coolant Pressure Boundary:** "Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leak tight integrity, and (2) an appropriate material surveillance program for the reactor pressure boundary."

During licensing of the currently operating plants, licensees demonstrated that the design of the reactor coolant pressure boundary meets these requirements or those in the proposed Appendix A, "General Design Criteria for Nuclear Power Plant Construction Permits," as published in the Federal Register on July 11, 1967. Although the criteria of the proposed Appendix A are different, they convey similar intent. The following information discusses application of the GDC for the cracking of pressurizer welds and nozzles:

- Pressurized water reactors licensed both before and after issuance of Appendix A to Part 50 (1971) complied with these criteria in part by: 1) selecting Alloy 600 or other austenitic materials with excellent corrosion resistance and extremely high fracture toughness, for reactor coolant pressure boundary materials, and 2) following ASME Codes and Standards and other applicable requirements for fabrication, erection, and testing of the pressure boundary parts. NRC reviews of operating license submittals subsequent to issuance of Appendix A included evaluating designs for compliance with the GDC. The SRPs (standard review plans) in effect at the time of licensing do not address the selection of Alloy 600. They only require that ASME code requirements be satisfied.
- Although stress corrosion cracking of primary coolant system welds was not originally anticipated during plant design, it has occurred in wrought material at several plants. Recently some axial cracks have been identified in a few alloy 600 butt welds at a small number of plants. The suitability of the originally selected materials has been confirmed. The robustness of the design has been demonstrated by the small amounts of the leakage that has occurred and by the fact that none of the cracks in Alloy 600 reactor coolant pressure boundary materials has rapidly propagated or resulted in catastrophic failure or gross rupture. It should be noted that the proposed Appendix A was written in terms of extremely low probability of gross rupture or significant leakage throughout the design life.

- ASME requirements for pressurizer dissimilar metal butt welds receive volumetric examination for welds 4" and greater. The component was designed for that inspection. Direct visual examination may be performed on instrument nozzles. As described above, the requirements established for design, fracture toughness, and inspectability in GDC 14, 31, and 32 respectively were satisfied during a plant's initial licensing review, and continue to be satisfied during operation, even in the presence of a potential for stress corrosion cracking of pressurizer welds.

All examinations have been performed in accordance with the ASME Section XI program since the beginning of plant operation including pre-service and the examination results are included in written reports. All examinations of these pressurizer alloy 82/182/600 locations are performed to written procedures by qualified personnel. As identified in the original Bulletin 2004-01 response, the Seabrook Station corrective action program will be used to disposition all findings of potential leakage. These actions satisfy the requirements of 10CFR 50 Appendix B Criteria V, IX, and XVI as identified in the applicable regulatory requirements section of NRC Bulletin 2004-01.

***NRC RAI 3:** Item 1(d) in Bulletin 2004-01 states, "In light of the information discussed in this bulletin and your understanding of the relevance of recent industry operating experience to your facility, explain why the inspection program identified in your response to item (1)(c) above is adequate for the purpose of maintaining the integrity of your facility's RCPB and for meeting all applicable regulatory requirements which pertain to your facility." The licensee's response to this item does not provide a specific explanation of these items. Please provide this explanation.*

### **Seabrook Station Response to RAI 3:**

#### **Butt Welds:**

The MRP Butt Weld Working Group has prepared a safety assessment report <sup>[iii]</sup> of the risks of leakage and pipe rupture as a result of PWSCC associated with alloy 82/182 butt welds. The main conclusion from the butt weld safety assessment is that the risk of leaks is low and the predicted change in core damage frequency is within the requirements of Reg. Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." The main contributing factors to this conclusion are as follows:

- ASME requirements for pressurizer dissimilar metal butt welds receive volumetric examination for welds 4 inch and greater. The component was designed for that inspection. Direct visual examination may be performed on other nozzles. As described in the response to RAI 1, the requirements established for design, fracture toughness, and inspectability in GDC 14, 31, and 32 respectively were satisfied during a plant's initial licensing review, and continue to be satisfied during operation, even in the presence of a potential for stress corrosion cracking of pressurizer welds.
- Despite there being approximately 1,150 Alloy 82/182 butt welds in domestic PWR plants greater than 1 inch NPS that operate at cold leg temperatures and above, only a few part depth axial cracks have been detected, only one leak (V.C. Summer) occurred associated with an axial crack that was limited to the width of the V-groove weld, and only one short and shallow circumferential crack has been detected. Including PWR

plants worldwide adds only a small number of part-depth axial cracks and one very small leak (Tsuruga 2).

- Most butt welds have been inspected at 10 year intervals per the requirements of the ASME Code Section XI or similar requirements worldwide. These inspections have included volumetric examination of welds 4 inch NPS and larger in diameter. The inspection sensitivity has continued to improve over time. The small number of cracks found by these inspections suggests that butt weld PWSCC is not widespread at present. All butt welds examined by UT or by surface examination methods from the outside surface also effectively receive a bare metal visual inspection as part of the NDE process.
- In addition to the nondestructive examinations required by the ASME Code, butt welds are inspected visually for boric acid leaks. The two leaks that have occurred to date (V.C. Summer and Tsuruga 2) were both discovered by visual inspections long before cracks reached critical size or there was any significant boric acid corrosion.
- Finite element stress analyses support the findings in the field that most cracks will be axially oriented. Field experience supports the conclusion that axial cracks will be limited to the width of the Alloy 82/182 weld metal, (except for the few cases involving Alloy 600 safe ends) since PWSCC cannot continue into low-alloy steel nozzles or into stainless steel piping on either side of the welds. The fact that the axial cracks arrest before the critical flaw size is reached justifies the use of leakage before risk of rupture even though this case involves an active degradation mechanism.
- In recognition of the importance of visual inspections in detecting leaks at an early stage, the MRP has recommended that all Alloy 82/182 butt weld locations be subjected to a bare metal visual inspection or other equivalent examination, within the next two refueling outages with priority given to inspecting the hot leg and pressurizer nozzle welds during the next outage.
- Analyses show that 360° part-depth circumferential flaws are unlikely to occur, that the critical length of through-wall circumferential flaws is large, and that for all except one location leak rates of 1 gallon per minute (gpm) will occur under normal loading conditions significantly before the flaw reaches a critical size even under seismic loading conditions. While the Technical Specification (3.4.6.2, Reactor Coolant System Leakage) limit is 1 gpm of unidentified leakage, plants are currently working to reduce unidentified leakage to much smaller values.
- Probabilistic fracture mechanics calculations show that the change in core damage frequency due to flaw growth in the 40th year of plant life ranges from  $1.85 \times 10^{-8}$  to  $8.74 \times 10^{-8}$  per year which is within the criteria of  $1 \times 10^{-6}$  specified by Regulatory Guide 1.174.
- While the potential for boric acid corrosion cannot be ruled out, the potential for significant boric acid corrosion is considered to be very low. The low risk is the result of nondestructive examinations to monitor the condition of Alloy 82/182 butt welds in the fleet, visual inspections for boric acid leakage during outages, on-line detection for larger leaks, practical experience with the two butt weld leaks that occurred at V.C. Summer and Tsuruga 2, and practical experience with a large number of leaks from Alloy 600 PWSCC at RPV top and bottom head nozzles, hot leg instrument nozzles, and pressurizer instrument nozzles and heater sleeves.

EPRI MRP is preparing an inspection and examination guideline based on this butt weld safety assessment report for the long term (40 years and beyond). This inspection guideline is the guidance referred to in the response to RAI number 1 above. Based on the safety assessment presented in MRP-113, "Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs," and the modification of the FPL Energy Seabrook commitment to continue to perform bare metal visual inspections of the alloy 182 spray, safety and surge nozzle butt welds, FPL Energy Seabrook considers these actions to be an effective degradation management program for Seabrook Station for the scope of this Bulletin. FPL Energy Seabrook will continue to monitor for the development of the EPRI MRP inspection and examination guideline for any changes to its actions.

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<sup>i</sup> FPL Letter L-2004-160, "Florida Power and Light Company, St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, Turkey Point Units 3 and 4, Docket Nos. 50-250 and 50-251, and FPL Energy Seabrook, LLC, Seabrook Station, Docket No. 50-443, NRC Bulletin 2004-01, Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized Water Reactors," J.A. Stall to the NRC, Dated July 27, 2004.

<sup>ii</sup> NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized Water Reactors," dated May 28, 2004.

<sup>iii</sup> EPRI Material Reliability Program Report MRP-113, Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs," MRP-113, EPRI, Palo Alto, CA: 2004. 1007029

Attachment 2

**NRC BULLETIN 2004-01: "INSPECTION OF ALLOY 82/182/600 MATERIALS  
USED IN THE FABRICATION OF PRESSURIZER PENETRATIONS AND STEAM  
SPACE PIPING CONNECTIONS AT PRESSURIZED WATER REACTORS,"  
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION  
FOR ST. LUCIE UNITS 1 AND 2**

Florida Power and Light Company (FPL) responded to the Nuclear Regulatory Commission (NRC) Bulletin 2004-01 by letter dated July 27, 2004. <sup>[iv]</sup> On November 23, 2004, the Nuclear Regulatory Commission (NRC) sent a request for additional information (RAI) regarding the FPL response to NRC Bulletin 2004-01<sup>[v]</sup> for St. Lucie Unit 1 and 2. Below are the responses to those RAI questions.

**NRC RAI 1:** *In item (1)(c) of the Florida Power and Light Company (FPL) response to the U.S. Nuclear Regulatory Commission (NRC) Bulletin 2004-01, it appears that FPL is stating that they may not be examining the Alloy 182 spray, safety and surge nozzle butt welds after the next refueling outage. Please clarify this statement in your Bulletin response since on page 5 of the Bulletin states, "The NRC staff has reviewed the recommendations made by the WOG [Westinghouse Owners Group] in its January 30, 2004, letter and finds that, with minor modifications, it would constitute an effective degradation management program for all Alloy 82/182/600 covered under the scope of Bulletin 2004-01 based on our current state of knowledge." These examinations should be performed at each refueling outage.*

**St. Lucie Unit 1 Response to RAI 1:** The St. Lucie Unit 1 pressurizer will be replaced at the next refueling outage (RFO) and no alloy 600/82/182 products will be used in pressure boundary applications including the alloy 182 spray, safety, relief and surge nozzle butt weld. There will be no refueling outage between the issuance of the NRC Bulletin 2004-01 and the replacement of the pressurizer. Therefore, the scope of this Bulletin is not applicable for St. Lucie Unit 1 for examination after the next refueling outage. In the event that the St. Lucie Unit 1 pressurizer is not replaced on schedule, FPL will perform bare metal visual inspections of the alloy 182 spray, safety and surge nozzle butt welds at each refueling outage until it is replaced or further butt weld inspection guidance is issued by EPRI MRP, the ASME Code, or regulatory action. At that time, FPL will follow the published guidance as it applies to the materials of the St. Lucie Unit 1 pressurizer configuration.

**St. Lucie Unit 2 Response to RAI 1:** FPL will perform a 100% bare metal visual examination (VT-2) of all the alloy 82/182/600 pressurizer penetrations and butt welds as identified in the original Bulletin 2004-01 response at the next RFO. That refueling outage has been rescheduled from the fall of 2004 to January 2005. FPL had identified that for subsequent bare metal VT-2 examinations of the alloy 182 spray, safety, relief and surge nozzle butt welds, St. Lucie Unit 2 will follow a frequency to be identified by the ASME Code, EPRI MRP, or regulatory action. EPRI MRP is currently drafting further inspection guidance for all alloy 82/182 butt welds. This guidance is due out in 2005. These inspection guidelines are expected to include an inspection frequency based on the temperature, size and level of mitigation that may have been previously applied. In the interim, FPL is modifying its response to indicate that St. Lucie Unit 2 will continue to perform bare metal visual inspections of the alloy 182 spray, safety and surge nozzle butt welds at each RFO until further butt weld inspection guidance is issued by EPRI MRP, the ASME Code, or regulatory action. At that time, FPL will follow the published guidance.

**NRC RAI 2:** *Items 1(b) and 1(c) in Bulletin 2004-01 request that FPL provide the basis for concluding that their plant will satisfy applicable regulatory requirements related to the structural and leakage Integrity of pressurizer penetrations and steam space piping connections. FPL response to this item does not provide a specific explanation of these items. Please supplement your response to provide this basis. The section titled, "Applicable Regulatory Requirements" starting on page 5 in Bulletin 2004-01 lists some of the regulatory requirements that should be addressed in your response.*

**St. Lucie Unit 1 and 2 Response to RAI 2:** The applicable general design criteria (GDC) identified in Bulletin 2004-01 includes GDC 14, GDC 31, and GDC 32. The three referenced general design criteria state the following:

- **Criterion 14 – Reactor Coolant Pressure Boundary:** "The reactor coolant pressure boundary shall be designed, fabricated, erected and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture."
- **Criterion 31 – Fracture Prevention of Reactor Coolant Pressure Boundary:** "The reactor coolant pressure boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a non-brittle manner, and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient thermal stresses, and (4) flaw sizes."
- **Criterion 32 – Inspection of Reactor Coolant Pressure Boundary:** "Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leak tight integrity, and (2) an appropriate material surveillance program for the reactor pressure boundary."

During licensing of the currently operating plants, licensees demonstrated that the design of the reactor coolant pressure boundary meets these requirements or those in the proposed Appendix A, "General Design Criteria for Nuclear Power Plant Construction Permits," as published in the Federal Register on July 11, 1967. Although the criteria of the proposed Appendix A are different, they convey similar intent. The following information discusses application of the GDC for the cracking of pressurizer welds and nozzles:

- Pressurized water reactors licensed both before and after issuance of Appendix A to Part 50 (1971) complied with these criteria in part by: 1) selecting Alloy 600 or other austenitic materials with excellent corrosion resistance and extremely high fracture toughness, for reactor coolant pressure boundary materials, and 2) following ASME Codes and Standards and other applicable requirements for fabrication, erection, and testing of the pressure boundary parts. NRC reviews of operating license submittals subsequent to issuance of Appendix A included evaluating designs for compliance with the GDC. The Standard Review Plans in effect at the time of

licensing do not address the selection of Alloy 600. They only require that ASME code requirements be satisfied.

- Although stress corrosion cracking of primary coolant system penetrations was not originally anticipated during plant design, it has occurred in wrought material at several plants. Recently some axial cracks have been identified in a few alloy 600 butt welds at a small number of plants. The suitability of the originally selected materials has been confirmed. The robustness of the design has been demonstrated by the small amounts of the leakage that has occurred and by the fact that none of the cracks in Alloy 600 reactor coolant pressure boundary materials has rapidly propagated or resulted in catastrophic failure or gross rupture. It should be noted that the proposed Appendix A was written in terms of extremely low probability of gross rupture or significant leakage throughout the design life.
- ASME requirements for pressurizer dissimilar metal butt welds receive volumetric examination for welds 4 inches and greater. The component was designed for that inspection. Direct visual examination may be performed on instrument nozzles and heater sleeves. As described above, the requirements established for design, fracture toughness, and inspectability in GDC 14, 31, and 32 respectively were satisfied during a plant's initial licensing review, and continue to be satisfied during operation, even in the presence of a potential for stress corrosion cracking of pressurizer welds and penetrations.

All examinations have been performed in accordance with the ASME Section XI program since the beginning of plant operation, including pre-service, and the examination results are included in written reports. All examinations of these pressurizer alloy 82/182/600 locations are performed to written procedures by qualified personnel. As identified in the original Bulletin 2004-01 response, the St. Lucie corrective action program will be used to disposition all findings of potential leakage. These actions satisfy the requirements of 10CFR 50 Appendix B Criteria V, IX, and XVI as identified in the applicable regulatory requirements section of NRC Bulletin 2004-01.

***NRC RAI 3: Item 1(d) in Bulletin 2004-01 states, "In light of the information discussed in this bulletin and your understanding of the relevance of recent industry operating experience to your facility, explain why the inspection program identified in your response to item (1)(c) above is adequate for the purpose of maintaining the integrity of your facility's RCPB and for meeting all applicable regulatory requirements which pertain to your facility." FPL response to this item does not provide a specific explanation of these items. Please provide this explanation.***

### **St. Lucie Unit 1 and 2 Response to RAI 3:**

#### **Butt Welds:**

The MRP Butt Weld Working Group has prepared a safety assessment report (MRP-113) <sup>[M]</sup> of the risks of leakage and pipe rupture as a result of PWSCC associated with alloy 82/182 butt welds. The main conclusion from the butt weld safety assessment is that the risk of leaks is low and the predicted change in core damage frequency is within the requirements of Reg. Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-

Informed Decisions on Plant-Specific Changes to the Licensing Basis.” The main contributing factors to this conclusion are as follows:

- ASME requirements for pressurizer dissimilar metal butt welds receive volumetric examination for welds 4 inches and greater. The component was designed for that inspection. Direct visual examination may be performed on instrument nozzles and heater sleeves. As described above, the requirements established for design, fracture toughness, and inspectability in GDC 14, 31, and 32 respectively were satisfied during a plant's initial licensing review, and continue to be satisfied during operation, even in the presence of a potential for stress corrosion cracking of pressurizer welds and penetrations.
- Despite there being approximately 1,150 Alloy 82/182 butt welds in domestic PWR plants greater than 1 inch NPS that operate at cold leg temperatures and above, only a few part depth axial cracks have been detected, only one leak (V.C. Summer) occurred associated with an axial crack that was limited to the width of the V-groove weld, and only one short and shallow circumferential crack has been detected. Including PWR plants worldwide adds only a small number of part-depth axial cracks and one very small leak (Tsuruga 2).
- Most butt welds have been inspected at 10-year intervals per the requirements of the ASME Code Section XI or similar requirements worldwide. These inspections have included volumetric examination of welds 4 inch NPS and larger in diameter. The inspection sensitivity has continued to improve over time. The small number of cracks found by these inspections suggest that butt weld PWSCC is not widespread at present. All butt welds examined by UT or by surface examination methods from the outside surface also effectively receive a bare metal visual inspection as part of the NDE process.
- In addition to the nondestructive examinations required by the ASME Code, butt welds are inspected visually for boric acid leaks. The two leaks that have occurred to date (V.C. Summer and Tsuruga 2) were both discovered by visual inspections long before cracks reached critical size or there was any significant boric acid corrosion.
- Finite element stress analyses support the findings in the field that most cracks will be axially oriented. Field experience supports the conclusion that axial cracks will be limited to the width of the Alloy 82/182 weld metal, except for the few cases involving Alloy 600 (safe ends) since PWSCC cannot continue into low-alloy steel nozzles or into stainless steel piping on either side of the welds. The fact that the axial cracks arrest before the critical flaw size is reached justifies the use of leakage before risk of rupture even though this case involves an active degradation mechanism.
- In recognition of the importance of visual inspections in detecting leaks at an early stage, the MRP has recommended that all Alloy 82/182 butt weld locations be subjected to a bare metal visual inspection or other equivalent examination, within the next two refueling outages with priority given to inspecting the hot leg and pressurizer nozzle welds during the next outage.
- Analyses show that 360° part-depth circumferential flaws are unlikely to occur, that the critical length of through-wall circumferential flaws is large, and that for all except one location leak rates of 1 gallon per minute (gpm) will occur under normal loading conditions significantly before the flaw reaches a critical size even under seismic loading

conditions. While the Technical Specification limit is 1 gpm of unidentified leakage, plants are currently working to reduce unidentified leakage to much smaller values.

- Probabilistic fracture mechanics calculations show that the change in core damage frequency due to flaw growth in the 40<sup>th</sup> year of plant life ranges from  $1.85 \times 10^{-8}$  to  $8.74 \times 10^{-8}$  per year which is within the criteria of  $1 \times 10^{-6}$  specified by Regulatory Guide 1.174.
- While the potential for boric acid corrosion cannot be ruled out, the potential for significant boric acid corrosion is considered to be very low. The low risk is the result of nondestructive examinations to monitor the condition of Alloy 82/182 butt welds in the fleet, visual inspections for boric acid leakage during outages, on-line detection for larger leaks, practical experience with the two butt weld leaks that occurred at V.C. Summer and Tsuruga 2, and practical experience with a large number of leaks from Alloy 600 PWSCC at RPV top and bottom head nozzles, hot leg instrument nozzles, and pressurizer instrument nozzles and heater sleeves.

EPRI MRP is preparing an inspection and examination guideline based on this butt weld safety assessment report for the long term (40 years and beyond). This inspection guideline is the guidance referred to in the response to RAI number 1 above.

#### **Partial Penetration Nozzles and Heater Sleeves:**

There have been numerous instances of Alloy 600 pressurizer instrument nozzle and heater sleeve leakage in the industry. Most recent leakage events were the result of axially-oriented PWSCC of the pressure boundary portion of pressurizer heater sleeves or instrument nozzles. Recent non-destructive examination results on heater sleeves have demonstrated that circumferentially oriented PWSCC can occur in the non-pressure boundary portion of these components. The Westinghouse Owners Group (WOG) provided an operational assessment addressing postulated circumferential cracking in CE designed pressurizer heater sleeves. That report was transmitted to the NRC along with a commitment <sup>[vii]</sup>, on behalf of licensees of CE Utilities, to address the heater sleeve issue by performing bare metal visual inspections every refueling outage and addressing NDE of leaking penetrations. FPL modified this commitment in the St. Lucie response to Bulletin 2004-01 question 1.c, to indicate the following:

"If the NDE of these alloy 82/182/600 materials defines a flaw as potential circumferential cracking, the NRC will be notified and an appropriate inspection plan will be developed. The plan will define expansion of NDE sufficient to determine the extent of condition commensurate with the characterization of the flaw."

The NRC identified in Bulletin 2004-01, that the WOG inspection recommendations in its January 30, 2004, letter, with minor modifications, would constitute an effective degradation management program for all Alloy 82/182/600 covered under the scope of Bulletin 2004-01 based on the current state of knowledge. The FPL modified commitment for the St. Lucie Plant addresses the minor modification concern identified in the Bulletin.

The St. Lucie Unit 2 pressurizer instrument nozzles (7) have been replaced with alloy 690/52/152. One of these pressurizer instrument nozzles has an alloy 82 pad weld and receives a bare metal visual inspection at every refueling outage by procedure. Four of the St. Lucie Unit 1 pressurizer instrument nozzles have been replaced with alloy 690/52/152

and the complete Unit 1 pressurizer is scheduled for replacement at the next refueling outage. Prior to the issuance of Bulletin 2004-01, FPL has been performing either complete or partial bare metal visual examinations of all the pressurizer small bore penetrations (heater sleeves and instrument nozzles) every RFO since 1990 at St. Lucie Units 1 and 2. The details of those inspections were provided in a Westinghouse Owners Group letter to the NRC. <sup>[viii]</sup>

Based on the assessment presented above, the scheduled replacement of the Unit 1 pressurizer and the planned inspections for Unit 2 constitute effective actions for maintaining the integrity of the reactor coolant system boundary and meeting applicable regulatory requirements. FPL considers these actions to be an effective degradation management program for St. Lucie Units 1 and 2 for the scope of this Bulletin.

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<sup>iv</sup> FPL Letter L-2004-160, "Florida Power and Light Company, St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, Turkey Point Units 3 and 4, Docket Nos. 50-250 and 50-251, and FPL Energy Seabrook, LLC, Seabrook Station, Docket No. 50-443, NRC Bulletin 2004-01, Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized Water Reactors," J.A. Stall to the NRC, Dated July 27, 2004.

<sup>v</sup> NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized Water Reactors," dated May 28, 2004.

<sup>vi</sup> EPRI Material Reliability Program Report MRP-113, Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs," MRP-113, EPRI, Palo Alto, CA: 2004. 1007029

<sup>vii</sup> WOG Letter 2004-057, "WOG CE Fleet Pressurizer Heater Sleeve Inspection Program," F. P. Schiffley II, Chairman, Westinghouse Owners Group to NRC, January 30, 2004. (ADAMS Accession # ML040480309)

<sup>viii</sup> WOG Letter 2003-643, "WOG CE Fleet Operability Assessment Regarding Pressurizer Heater Sleeves," F. P. Schiffley II, Chairman, Westinghouse Owners Group to NRC, December 23, 2003. (ADAMS Accession # ML033650391)